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| 14. ABSTRACT Recently, researchers proposed Collaboration Support Systems (CSS) as a new class of collaboration technology with which a collaboration engineer could package collaboration expertise with collaboration technology in a form that non-experts could use to successfully execute a work practice without extensive training on either the technology or the techniques | | | | | |
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Project Accomplishments

Intellectual Achievements:

- Created a taxonomy of Collaboration Technology used as a foundation for process support systems (PSS) component capabilities.
- Derived a 7 layer model of collaboration which was adopted by USSTRATACOM's GISC as the foundation for designing and measuring large-scale multi-agency collaborative intelligence analysis exercises. Derived the inductive and deductive logical foundations for the Seven Layer Model of Collaboration.
- Developed conceptual foundations for the Universal Data Model
- Created an ontology for collaboration processes and systems
- Defined generalized requirements for Collaboration Support Systems (CSS) and for the primary CSS sub-systems, Computer Assisted Collaboration Engineering (CACE) and Process Support Systems (PSS).
- Created first draft of Collaboration Engineering Modeling Language (CEML) standard

Technical Achievements:

- Conducted three international requirements workshops for architectural design of Computer Assisted Collaboration Engineering (CACE) and PSS
 - Created a server-side data architecture around a Universal Data Model
 - Created a collaborative messaging architecture.
 - Created a browser-based client architecture for CACE
 - Created conceptual class architecture for ActionCenters
 - Established developer coding standards for CACE/PSS
- Specified data requirements for ActionCenter elements
- Created conceptual UI/UX designs for Agenda Editor, Activity Editor, ActionCenter Builder, and Screen Editor.
- Implemented CACE framework, Project Explorer, Security, Administration, User Management, and Recycle Bin for the CACE tool
- Implemented three technical innovations that should reduce development cycles for collaboration software:
 - Universal Data Model (UDM). A server that accepts any data in any set of relationships in real time without having to revise server-side metadata.

- Dynamic Contribution Channels (DCC). Clients receive metadata at run time, and instruct the server what events to publish.
 - Collaboration Support API (CSAPI). Packages difficult-to-build aspects of collaboration technology in a new class of middleware.
- Developed the ARCADE API (descended from the CSAPI) as the foundation for the ActionCenters CACE. Allows for the group-enabling of events with one or two lines of code. A pilot project based on the ARCADE API demonstrated development cycle reductions of 90% and more for collaborative components.
- Developed single, double, and triple indirect capabilities to disambiguate complex relationships among contributions to a collaborative system.
- Produced the first fully functional ActionCenter prototype for a military Course of Action Development process using the UDM, DCC, and CSAPI capabilities in order to exercise the back-end capabilities and to test UI concepts for ActionCenters.
- Implemented a Computer Assisted Collaboration Engineering (CACE) rapid development environment with an open, extensible architecture that accepts plug-in collaborative design and configuration editors, and plug-in collaborative components.
- Implemented editors and components and plugged them into the CACE framework:
 - Project Explorer
 - ActionCenter Builder
 - Element Editor
 - Palette Explorer
 - Activity, Standard Activity, Screen, Tool, Control, and Image components
 - Roster Component
 - Navigation Component
 - Outliner Component and derivatives:
 - List Component
 - Commenter Component
 - Annotation Component
 - Parent-Child Shell Component
 - File Repository Component
 - Symbol-and-arrow Diagram Component
- Implemented a Standard Activity insertion capability for runtime ActionCenters. Developed a collection of standard Collaborative Tools from ActionCenters components:
 - Outline Builder
 - Idea Swapper
 - Idea Organizer
 - Idea Presenter
- Produced several prototype ActionCenters applications the new CACE capability
 - COA Development
 - Creative Problem Solving
 - Marketing Focus Groups
 - Risk Assessment
 - Commander's Intent

Archival publications (published) during reporting period:

Journal Articles:

1. BADURA, V., READ, A., BRIGGS, R.O., VREEDE, G.J. DE (IN PRESS), Coding for Unique Ideas and Ambiguity: The effects of Convergence Intervention on the Artifact of an Ideation Activity, *International Journal of Social and Organizational Dynamics in IT*.
2. BRIGGS, R. O., REINIG, B. A., & VREEDE, G. J. D. (2008). The Yield Shift Theory of Satisfaction and its application to the IS/IT domain. *Journal of the Association for Information Systems*, 9(5), 267-293. <http://aisel.aisnet.org/jais/vol9/iss5/2>
3. BRIGGS, R.O. AND MURPHY, J. (In Press). Discovering and Evaluating Collaboration Engineering Opportunities: An Interview Protocol Based on the Value Frequency Model. *Group Decision and Negotiation*.
4. DEOKAR, A., KOLFSCHOTEN, G.L., VREEDE, G.J. DE (2008), Prescriptive Workflow Design for Collaboration-intensive Processes using the Collaboration Engineering Approach, *Global Journal of Flexible Systems Management*, 9(4), 13-24.
5. KOLFSCHOTEN, G.L. FRANTZESKAKI, N. DE HAAN, A. VERBRAECK, A. (2008), Collaborative modeling lab to increase learning engagement, *Journal of the Higher Education Academy Engineering Subject Center*, Volume3 issue2, pp.21
6. Kolfschoten, G.L., Briggs, R.O., & Grünbacher, P. (In Press) Modifiers for quality assurance in group facilitation. *Group Decision and Negotiation*
7. Kolfschoten, G.L., Briggs, R.O., & Lukosch, S. (2011). Modifiers: Increasing Richness and Nuance of Design Pattern Languages. *Transactions on Pattern Languages of Programming II, Special Issue on Applying Patterns*. *Lecture Notes on Computer Science* 6510, 62-78.
8. KOLFSCHOTEN, G.L., LUKOSCH, S., VERBRAECK, A., VALENTIN, E., VREEDE, G.J. DE (IN PRESS), Cognitive learning efficiency through the use of design patterns in teaching, *Computers in Education*.
9. KOLFSCHOTEN, G.L., SECK, M., VREEDE, G.J. DE (2010), How Interactive Whiteboards can be used to Support Collaborative Modeling, *Journal of Universal Computing Science*, 15(16), 3126-3138.
10. Kolfschoten, G.L., Vreede, G.J, Briggs, R.O, and Sol, H. (2010). Collaboration Engineerability. *Group Decision and Negotiation Journal* 19(3), pp. 301-312.
11. KOLFSCHOTEN, G.L., VREEDE, G.J. DE (in Press), A Design Approach for Collaboration Processes: A Multi-Method Design Science Study in Collaboration Engineering, *Journal of Management Information Systems*.
12. KOLFSCHOTEN, G.L., VREEDE, G.J. DE, BRIGGS, R.O., SOL, H.G. (in Press), Collaboration 'Engineerability', *Group Decision & Negotiation*.
13. KOLFSCHOTEN, G.L., VREEDE, G.J. DE, PIETRON, L.R. (IN PRESS), A training approach for the transition of repeatable collaboration processes to practitioners, *Group Decision & Negotiation*.
14. NABUKENYA, J., BOMMEL, P. VAN, PROPER, H.A, VREEDE, G.J., DE (IN PRESS), An Evaluation Instrument for Collaborative Processes: Application to Organizational Policy Making, *Group Decision and Negotiation*.
15. NIEDERMAN, F., BRIGGS, R. O., VREEDE, G. J. D., & KOLFSCHOTEN, G. L. (2008). Extending the contextual and organizational elements of adaptive structurization theory in GSS research. *Journal of the Association for Information Systems*, 9(10/11), 633-652.

16. NIEDERMAN, F., BRIGGS, R.O., VREEDE, G.J. DE, KOLFSCHOTEN, G.L. (2008), Purposive Adaptive Structuration: The role of conscious agents in creating and utilizing new structures in collaboration, *Journal of the Association for Information Systems*, 9, 10.
17. NUNAMAKER, J. F., JR., REINIG, B. A., & BRIGGS, R. O. (2009). Principles for Effective Virtual Teamwork. *Communications of the ACM*, 52 (4), Pages 113-117.
18. REINIG, B. A., & BRIGGS, R. O. (2008). on the relationship between idea-quantity and idea-quality during ideation. *Group Decision and Negotiation*, 17(5), 403-420.
19. REINIG, B., BRIGGS, R.O., VREEDE, G.J. DE (2009), A Cross-cultural study of the Relationship between Perceived Changes in Likelihood of Goal Attainment and Satisfaction with Technology Supported Collaboration, *International Journal for e-Collaboration*, 5(2), 61-74
20. RENGGER, M., KOLFSCHOTEN, G.L., VREEDE, G.J. DE (2008), Challenges in Collaborative Modeling: A Literature Review & Research Agenda, *International Journal of Simulation and Process Modeling*, 4(3/4), 248-263.
21. Vreede, G. J. de, R. O. Briggs, et al. (2009). Collaboration Engineering: Foundations and Opportunities: Editorial to the Special Issue on the Journal of the Association of Information Systems. *Journal of the Association for Information Systems* 10(3), pp. 121-137.
22. VREEDE, G.J. DE, BRIGGS, R.O., MASSEY, A. (2009), Collaboration Engineering: Foundations and Opportunities, Editorial, *Journal of the Association of Information Systems*, 10(3), 121-137.
23. VREEDE, G.J. DE, BRIGGS, R.O., REITER-PALMON, R. (IN PRESS), Exploring Asynchronous Brainstorming in Large Groups: A Field Comparison of Serial and Parallel Subgroups, *Human Factors: The Journal of Human Factors and Ergonomics Society*.

Conference Proceedings:

1. ALJAFARI, R., VREEDE, G.J. DE (2010), A Review of Anonymity in Collaborative Settings, *Proceedings of Group Decision & Negotiation 2010*, Delft, the Netherlands, June 2010.
2. Badura, V., Read, A., Briggs, R.O., & Vreede, G.J. de. (2009). Exploring the Effects of a Convergence Intervention on Ideation Artifacts: A Multi-Group Field Study. *Proceedings of AMCIS 2009, The Americas Conference on Information Systems*, 1-9.
3. *Proceedings of AMCIS 2009, The Americas Conference on Information Systems*, 1-9.
4. Badura, V., Read, A., Briggs, R.O., and Vreede, G.J. (2010). Coding for Unique Ideas and Ambiguity: The Effects of a Convergence Intervention on the Artifact of an Ideation Activity. *Proceedings of the 43rd. Hawaii International Conference on System Sciences*. IEEE, pp. 1-10 (On CD).
5. Badura, V., Read, A.S., Briggs, R.O., & Vreede, G.J. de. (2009). Exploring The Effects of a Convergence Intervention On The Artifacts of an Ideation Activity During Sensemaking, in: Edick, N., & Vreede, G.J. de (eds.), *Proceedings of the Advances in Collaboration Science Research*, Third Research Seminar of the Center for Collaboration Science, 27 February, University of Nebraska Read, A.S., Renger, M., Briggs, R.O., & Vreede, G.J. de. (2009). *Fundamental Topics of Organizing: A Research Agenda*. Proceedings of the 42nd Hawaii International Conference on System Sciences, 1-10 (on CD).
6. BADURA, V., READ, A.S., BRIGGS, R.O., VREEDE, G.J. De (2009). Exploring The Effects of a Convergence Intervention on The Artifacts of An Ideation Activity During Sensemaking, In: Edick, N., Vreede, G.J. De (Eds.), *Proceedings of The Advances in Collaboration*

Science Research, Third Research Seminar of The Center For Collaboration Science, 27 February 2009, University of Nebraska

7. Boughzala, I. and Briggs, R.O. Knowledge Sharability in Cross-organizational Collaboration: An Exploratory Field Study. *Proceedings of the 44th Hawaii International Conference on System Sciences*. IEEE, pp. 1-10. (On CD).
8. BRIGGS, R. O., DAVIS, A. J., & MURPHY, J. D. (2008). *An Interview Protocol For Discovering And Assessing Collaboration Engineering Opportunities*. Proceedings of The 41ST Hawaii International Conference on System Sciences, 1-10, on Cd.
9. Briggs, R.O. and Schwabe, G. (2011) On Expanding the Scope of Design Science Research. In H. Jain, A.P. Sinha, and P. Vitharana (Eds.): Proceedings of Design Science Research in Information Systems and Technologies: DESRIST 2011, LNCS 6629, pp. 92–106, 2011.
10. BRIGGS, R.O., KOLFSCHOTEN, G.L., VREEDE, G.J. DE, ALBRECHT, C., LUKOSCH, S. (2010), Facilitator in a Box: Computer Assisted Collaboration Engineering and Process Support Systems for Rapid Development of Collaborative Applications for High-Value Tasks, *HICSS 2010*.
11. BRIGGS, R.O., KOLFSCHOTEN, G.L., VREEDE, G.J. DE, DEAN, D.L., LUKOSCH, S. (2009), A Seven Layer Model of Collaboration: Good Technology is Not Enough, *30th International Conference on Information Systems*, Phoenix, December 2009.
12. Briggs, R.O., Kolfschoten, G.L., Vreede, G.J. de; Albrecht, C.C., and Lukosch, S.G. (2010). Facilitator in a Box: Computer Assisted Collaboration Engineering and Process Support Systems for Rapid Development of Collaborative Applications for High-Value Tasks. *Proceedings of the 43rd. Hawaii International Conference on System Sciences*. IEEE, pp. 1-10 (On CD).
13. Briggs, R.O., Kolfschoten, G.L., Vreede, G.J.de, Albrecht, C.C., Lukosch, S.G., & Dean, D.L. (2009) A Seven-Layer Model of Collaboration: Separation of Concerns for Designers of Collaboration Systems. *Proceedings of the International Conference on Information Systems*. AIS Press, Pages 1-14 (On CD).
14. BRIGGS, R.O., KOLFSCHOTEN, G.L., VREEDE, G.J.DE, ALBRECHT, C.C., LUKOSCH, S.G., & DEAN, D.L. (2009) A Seven-Layer Model of Collaboration: Separation of Concerns for Designers of Collaboration Systems. *Proceedings of the International Conference on Information Systems*. AIS Press, Pages 1-14 (On CD).
15. Briggs, R.O., Murphy, J., Davis, A.J., & Carlisle, T. (2009). *Predicting Change: A Study of the Value Frequency Model for Change of Practice*. Proceedings of the 42nd Hawaii International Conference on System Sciences, 1-10 (on CD).
16. BRIGGS, R.O., MURPHY, J., DAVIS, A.J., AND CARLISLE, T. (2009). *Predicting Change: A Study of The Value Frequency Model For Change of Practice*. Proceedings of The 42ND Hawaii International Conference on System Sciences, 1-10, on Cd.
17. Briggs, R.O., Vreede, G.J. de, Reiter-Palmon, R., & Harland, L. (2009). Computer Assisted Collaboration Engineering and Process Support Systems: The BattleSpace ActionCenters Project, in: Edick, N., & Vreede, G.J. de (eds.), *Proceedings of the Advances in Collaboration Science Research*, Third Research Seminar of the Center for Collaboration Science, 27 February, University of Nebraska at Omaha, Omaha, NE.
18. BRIGGS, R.O., VREEDE, G.J. DE, REITER-PALMON, R., HARLAND, L. (2009). Computer Assisted Collaboration Engineering And Process Support Systems: The Battlespace Actioncenters

Project, In: Edick, N., Vreede, G.J. De (Eds.), *Proceedings of The Advances in Collaboration Science Research*, Third Research Seminar of The Center For Collaboration Science, 27 February 2009, University of Nebraska At Omaha, Omaha, Ne.

19. BRIGGS, R.O., VREEDE, G.J. DE, REITER-PALMON, R., HARLAND, L. (2009), Computer Assisted Collaboration Engineering And Process Support Systems: The Battlespace Actioncenters Project, in: Edick, N., Vreede, G.J. de (eds.), *Proceedings of the Advances in Collaboration Science Research*, Third Research Seminar of the Center for Collaboration Science, 27 February 2009, University of Nebraska at Omaha, Omaha, NE.
20. DAVIS, A., BADURA, V., VREEDE, G.J. DE (2008), Understanding Methodological Differences to Study Convergence in Group Support System Sessions, *CRIWG 2008*, September 14-18, Omaha, Nebraska.
21. DUIVENVOORDE, G.P.J., LUKOSCH, S.G., VREEDE, G.J. DE, VERBRAECK, A., OVERBEEK, S.J. (2010), Supporting convergence in groups: design and evaluation of idea similarity detection and a pre-selection method, *Proceedings of Group Decision & Negotiation 2010*, Delft, the Netherlands, June 2010.
22. DUIVENVOORDE, G.P.J.; KOLFSCHOTEN, G.L.; BRIGGS, R.O. AND VREEDE, G.J. DE (2009). Towards An Instrument to Measure Successfulness of Collaborative Effort From A Participant Perspective, Hawaii International Conference on System Science, Waikoloa, Ieee
23. FRANTZESKAKI, N. DE HAAN, A. DI RUGGERO, O. AND KOLFSCHOTEN, G.L. (2009) "Lessons Learned From a Multi-Modal Conceptual Modeling Course - The "Introduction to Policy Analysis" Course's Experience As a Successful Grassroots Project of The Delft University of Technology," In *Inted*, Pp. 1-9.
24. FRANTZESKAKI, N. DE HAAN, A. WALKER W. AND KOLFSCHOTEN, G.L. (2008), Three Challenges, Four Pitfalls And Five Solutions When Teaching Conceptual Modeling, International Conference of Education, Research And Innovation (Iceri 2008), 17-19 November 2008, Madrid (Spain).
25. Herzfeldt, A., Briggs, R.O., Read, A., Krcmar, H. (2010). Toward a Taxonomy of Requirements for Hybrid Products. *Proceedings of the 44th Hawaii International Conference on System Sciences*. IEEE, pp. 1-10. (On CD).
26. KOLFSCHOTEN, G. L., & BRIGGS, R. O. (In Press). *Modifiers: Increasing Richness And Nuance of Design Pattern Languages*. Proceedings of the European Conference on Pattern Languages of Programs, Irsee, Uvk.
27. Kolfschoten, G. L., Duivenvoorde, G., Briggs, R. O., & Vreede, G. J. de. (2009). *Towards an Instrument to Measure Successfulness of Collaborative Effort from a Participant Perspective*. Proceedings of the 42nd Hawaii International Conference on System Sciences, 1-10 (on CD).
28. KOLFSCHOTEN, G. L., GRÜNBACHER, P., & BRIGGS, R. O. (2008). *Modifiers For Quality Assurance in Group Facilitation*. Groupware: Design, Implementation, And Use: 14TH International Workshop, CRIWG 2008. Omaha, Nebraska, September 2008, Proceedings.
29. KOLFSCHOTEN, G.L. AND BRIGGS, R.O. (2008) *Modifiers: Increasing Richness And Nuance of Design Pattern Languages*. Proceedings of the European Conference on Pattern Languages of Programs, Irsee, Uvk.
30. Kolfschoten, G.L. Briggs, R.O., & Vreede, G.J. de (2009). A Diagnostic to Identify and Resolve Different Sources of Disagreement in Collaborative Requirements Engineering.

Proceedings of the International Conference on Group Decision and Negotiation, Toronto, 100-108.

31. KOLFSCHOTEN, G.L., BRIGGS, R.O., VREEDE, G.J. DE (2009), A Diagnostic To Identify And Resolve Different Sources of Disagreement in Requirements Engineering, In: Kilgour, M., Wang, Q. (Eds), *Proceedings of GDN 2009: An International Conference on Group Decision And Negotiation*, Toronto, Canada, June 2009, P. 108-116.
32. KOLFSCHOTEN, G.L., DUIVENVOORDE, G., BRIGGS, R.O., VREEDE, G.J. DE (2009), Practitioners Vs Facilitators A Comparison of Participant Perceptions on Success, *Proceedings of the 42ND Hawaiian International Conference on System Sciences*, Los Alamitos: Ieee Computer Society Press.
33. KOLFSCHOTEN, G.L., DUIVENVOORDE, G., BRIGGS, R.O., VREEDE, G.J. DE (2009), Towards An Instrument to Measure Successfulness of Collaborative Effort From a Participant Perspective, *Proceedings of the 42ND Hawaiian International Conference on System Sciences*, Los Alamitos: Ieee Computer Society Press.
34. Kolfschoten, G.L., Duivenvoorde, G.P.J., Briggs, R.O., & Vreede, G.J. de. (2009). *Practitioners vs. Facilitators a Comparison of Participant Perceptions on Success*. Proceedings of the 42nd Hawaii International Conference on System Sciences, 1-10 (on CD).
35. KOLFSCHOTEN, G.L., KOSTERBOK, J. HOEKSTRA, A. (2008). A Transferable Thinklet Based Process Design For Integrity Risk Assessment in Government Organizations, Proceedings of the Group Decision And Negotiation Conference, Coimbra, Inesc Coimbra.
36. KOLFSCHOTEN, G.L.; FRANTZESKAKI, N.; HAAN, A. DE; DUIVENVOORDE, G.P.J. AND VERBRAECK, A. (2009). Collaborative Modeling Lab to Increase Learning Engagement; Comparing Manual Modeling With Interactive Whiteboards, Hawaii International Conference on System Science, Waikoloa, Ieee Computer Society Press.
37. KOLFSCHOTEN, G.L.; GRUNBACHER, P. AND BRIGGS, R.O. (2008). Modifiers For Quality Assurance in Group Facilitation, In: Briggs, R.O., Antunes, P. And Vreede, G.J. (Eds.) *Groupware: Design, Implementation And Use*, Proceedings of Criwig, Omaha, Usa, LNCS Springer-Verlag.
38. KOLFSCHOTEN, G.L.; NIEDERMAN, F.; VREEDE, G.J. DE AND BRIGGS, R.O. (2008). Roles in Collaboration Support And the Effect on Sustained Collaboration Support, Hawaii International Conference on System Science, Waikoloa, Ieee Computer Society Press.
39. Mametjanov, A., Kjeldgaard, D., Pettepier, T., Albrecht, C., Lukosch, S., and Briggs, R.O. ARCADE: Action-centered Rapid Collaborative Application Development and Execution. *Proceedings of the 44th Hawaii International Conference on System Sciences*. IEEE, pp. 1-10. (On CD).
40. MITTLEMAN, D. M., BRIGGS, R. O., MURPHY, J. D., & DAVIS, A. J. (2008). *Towards a Taxonomy of Groupware Technologies*. Groupware: Design, Implementation, And Use: 14TH International Workshop, CRIWG 2008. Omaha, Nebraska, September 2008.
41. Murphy, J. D., Wolcott, P., & Briggs, R. O. (2010). A Reconceptualization of the Value Frequency Model. *Proceedings of the 11th Group Decision & Negotiation 2010*, Delft, The Netherlands, pp. 1-15 (On CD).

42. Murphy, J.D.; Briggs, R.O.; and Najjar, L. (2010) TAM or VFM? Which Model Matches How People Ascribe Actual Value? (2010). *MWAIS 2010 Proceedings*. Paper 17, pp 1-8. <http://aisel.aisnet.org/mwais2010/17>.
43. NEWLON, C.M., PFAFF, M., PATEL, H., VREEDE, G.J. DE, MACDORMAN, K. (2009), Mega-Collaboration: the Inspiration And Development of An Interface For Large-Scale Disaster Response, *6TH International Conference on Information Systems For Crisis Response And Management (Iscram)*, 10-13 May 2009, Göteborg, Sweden.
44. NGUYEN, C., GALLAGHER, E., READ, A., VREEDE, G.J. DE (2009), Generating User Stories in Groups, *CRIWG 2009*.
45. Piirainen, K. and Briggs, R.O. (In Press). Design Theory in Practice. Making Design Science Research More Transparent. *Proceedings of the 2011 Design Science Research in Information Systems conference (DESRIST 2011)*.
46. Read, A. S., Renger, D. R. M., Briggs, R. O., & Vreede, G. J. de. (2009). *Fundamental Topics of Organizing: A Research Agenda*. Proceedings of the 42nd Hawaii International Conference on System Sciences.
47. Read, A., Arreola, N., and Briggs, R.O. (2010) The Role of the Story Master: A Case Study of the Cognitive Load of Story Management Tasks. *Proceedings of the 44th Hawaii International Conference on System Sciences*. IEEE, pp. 1-10. (On CD).
48. READ, A., BRIGGS, R.O., & VREEDE, G.J. DE. (2009). Understanding Relationships in Software Requirements, *Proceedings of the CORS-INFORMS International Meeting*, Toronto, Canada, June, 14-17.
49. READ, A., BRIGGS, R.O., VREEDE, G.J. DE (2009), Understanding Relationships in Software Requirements, *Proceedings of the Cors-Informs International Meeting*, Toronto, Canada, 14-17 June 2009.
50. READ, A., NGUYEN, C., GALLAGHER, E., VREEDE, G.J. DE (2009), Generating User Stories in Groups, *Mwais 2009*, Madison, Sd, 22-23 May 2009.
51. READ, A.S., RENGGER, D.R.M., BRIGGS, R.O., VREEDE, G.J. DE (2009), Fundamental Topics of Organizing: A Research Agenda, *Proceedings of the 42ND Hawaiian International Conference on System Sciences*, Los Alamitos: Ieee Computer Society Press.
52. RENGGER, M., KOLFSCHOTEN, G.L., VREEDE, G.J. DE (2008), Challenges With Collaborative Modeling: A Literature Review, In: Jan L.G. Dietz, Antonia Albani, Joseph Barjis, Peter Rittgen (Eds), *Advanced Enterprise Engineering*, Lecture Notes in Business Information Processing, Berlin: Springer-Verlag (*Ais Sigmas Best Paper Award*).
53. RENGGER, M., KOLFSCHOTEN, G.L., VREEDE, G.J. DE (2008), Patterns in Collaborative Modeling: A Literature Review, In: Costa, J. (Ed.), *Proceedings of Group Decision & Negotiation 2008*, Coimbra, Portugal.
54. RENGGER, M., KOLFSCHOTEN, G.L., VREEDE, G.J. DE (2008), Using Interactive Whiteboard Technology to Support Collaborative Modeling, *CRIWG 2008*, September 14-18, Omaha, Nebraska.
55. Sindhav, B., Reinig, B.A. and Briggs, R.O. (2010) A Field Investigation of the Nostalgia Effect. {Mametjanov, #2067}of the 44th Hawaii International Conference on System Sciences. IEEE, pp. 1-10. (On CD).
56. STEINHAUSER, L., READ, A., VREEDE, G.J. DE (2008), Studying the Adoption of Collaborative Work Practices Using the Value Frequency Model, In: Germonprez, M., Iversen, J. (Eds),

Proceedings of the Midwest United States Association For Information Systems 3RD Annual Conference, Eau Claire, Wisconsin, May 2008.

57. VREEDE, G.J. DE, BRIGGS, R.O. REINIG, B. (2008), E-Collaboration Satisfaction: Empirical Field Studies of Disconfirmation Theory Across Two Countries, *Proceedings of AMCIS-14*, August 14-17, Toronto, Canada.

Book (Chapters):

1. KOLFSCHOTEN, G.L., LOWRY, P.B., DEAN, D.L., VREEDE, G.J. DE, BRIGGS, R.O., Patterns in Collaboration, Nunamaker, J.F. Jr., Romano, N.C. Jr., Briggs, R.O. (eds), *AMIS Volume on Collaboration Science*.
2. KOLFSCHOTEN, G.L., VREEDE, G.J. DE, BRIGGS, R.O. (IN PRESS), Collaboration Engineering. In Kilgour, D. M. & Eden, C. (Eds.). *Handbook of Group Decision and Negotiation*. Dordrecht: Springer.
3. MARSHALL, G., & VREEDE, G. J. DE (EDS.). (2010). *Proceedings of the Advances in Collaboration Science Research*. Fourth Annual Research Seminar of the Center for Collaboration Science. Omaha: University of Nebraska at Omaha.
4. KOLFSCHOTEN, G.L., BRIGGS, R.O., & VREEDE, G.J. DE (2009). A technology for pattern-based design and its application to collaboration engineering. In Rummler, Scott and Ng, K.B. (eds.), *Collaborative Technologies and Applications for Interactive Information Design: Emerging Trends in User Experiences*. Hershey, PA: IGI Global, Information Science Reference, 1-18.
5. KOLFSCHOTEN, G.L. BRIGGS, R.O. & VREEDE, G.J. DE (2009). Design patterns for facilitation in e-collaboration, in N. Kock (Ed.), *E-Collaboration: Concepts, Methodologies, Tools, and Applications*. New Jersey: IGI Global Information Science Reference.

Conference Abstracts:

1. READ, A., BRIGGS, R.O., VREEDE, G.J. DE (2009), Understanding Relationships in Software Requirements, In: Kilgour, M., Wang, Q. (Eds), *Proceedings of GDN 2009: An International Conference on Group Decision And Negotiation*, Toronto, Canada, 14-17 June 2009, P. 150.
2. VREEDE, G.J. DE (2009), Collaboration Engineering: Technical And Methodological Advances, In: Kilgour, M., Wang, Q. (Eds), *Proceedings of GDN 2009: An International Conference on Group Decision And Negotiation*, Toronto, Canada, 14-17 June 2009, P. 178.

Electronic copies of these publications are available upon request.

Changes in research objectives, if any: None

Change in AFOSR program manager, if any:

Dr. David Luginbuhl left AFOSR, and no other program manager was assigned to the project.

Extensions granted or milestones slipped, if any: None

Include any new discoveries, inventions, or patent disclosures during this reporting period (if none, report none):

None

Appendix A

Source Code Listing for the ActionCenters Collaboration Support Systems

The Source code for the ActionCenters prototype is too large to include as an e-mail attachment. It can therefore be retrieved from this URL:

[shttps://actioncenters.svn.sourceforge.net/svnroot/actioncenters/trunk/AC/](https://actioncenters.svn.sourceforge.net/svnroot/actioncenters/trunk/AC/)

Appendix B

Unpublished Technical Paper

Indirectors to Support Complex Relationships in the Universal Data Model for Collaboration Technology

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Indirectors to Support Complex Relationships in the Universal Data Model for Collaboration Technology

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Keywords: Computer-Assisted Collaboration Engineering, Collaboration Support Systems, Collaboration middleware, Universal Data Model.

1 Introduction

Recently, researchers proposed Collaboration Support Systems (CSS) as a new class of collaboration technology with which a collaboration engineer could package collaboration expertise with collaboration technology in a form that non-experts could use to successfully execute a work practice without extensive training on either the technology or the techniques [1]. To speed the development of CSS capabilities colleagues proposed and tested a middleware API for CSS development that encapsulates many of the difficult-to-build aspects of collaboration technology in the form of abstractions that programmers can reuse to cut development cycles for real-time collaborative components by about 90% [2]. The API sits on a universal data service that can accept any form of data in any set of relationships in real time without having to modify the metadata on the backend data store. The data store consists of a fixed set of tables organized around entities, attributes and relationships. The middleware abstractions provide a generic graph-based data manipulation of entities as nodes and relationships as edges. The conception of the universal data service assumed a hierarchical data model where any data object could be uniquely determined by a given set of relationships to superior objects.

There are, however, use cases where more-complex relationships are required. It may be useful for the same object to appear as a subordinate to several superior objects. Changes to the object in one context would be reflected in all other contexts where it appears. Consider, for instance a risk assessment scenario where a single control (a subordinate) could mitigate several risks (superiors), or a software engineering context where a single feature could fulfill several requirements. In some cases, it is valuable for an object to have the same subordinates in all contexts where it appears. In the risk assessment scenario, for example, it would be useful for the strengths and limitations (subordinates) associated with a control (superior) to appear with it under every risk that it mitigates. In other cases, it may be valuable for an object to appear with different subordinates in each context where it appears. In the software requirements scenario, for example, it would be valuable for a feature to appear with a different justification under each requirement that it fulfills.

The goal is to create among all appearances of the entity a sharing of attributes and/or superior/subordinate entities.. This paper proposes a data sharing solution using *indirectors* within the previously proposed Universal Data Model (UDM).

2 Universal Data Model

To set the scene for the paper, we begin with a brief overview of the UDM [2]. Figure 1 summarizes the core of the model. In particular, entities define data objects, which can have zero or more attributes and can be related to other data objects with zero or more superior/subordinate relationships.

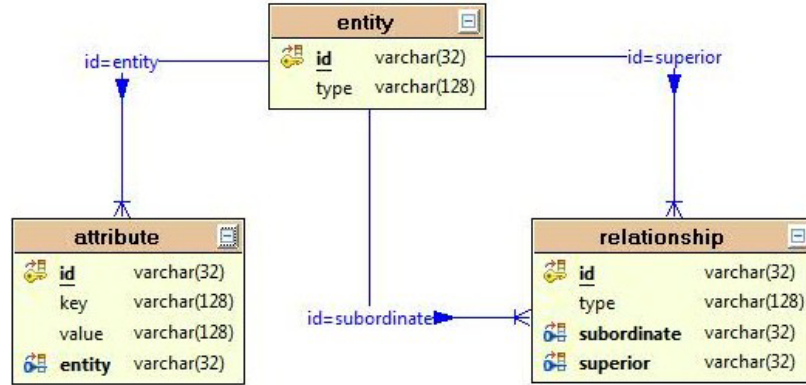


Fig. 1. Illustration of the core of the Universal Data Model capable of storing any data types with any attributes in any relationships. New data and new relationships can be stored in the same set of universal tables.

The primary benefit of the model is its generic nature. The same fixed set of tables can describe arbitrary relational data. Combined with graph-based data manipulation API, the same UDM-based data store can be used by multiple front-end client platforms to create new entities and relate them to existing data [2].

3 Indirectors in the UDM

The context of an entity in the UDM-based data store is determined by the entity's superiors. If the same entity with its subordinates needs to be used in a different context, then a new superior could be added to the entity. However, addition of new superiors may alter the existing context producing unintended side effects. For example, in CACE-based collaborative session screen design settings [1], if a certain screen object S with its subordinates, which define the screen's configuration, needs to be shown for a user in role R_1 during collaborative activity A_1 , then this context can be described by a set of relationships where S is a subordinate of R_1 and A_1 : i.e. $R_1 \rightarrow S$ and $A_1 \rightarrow S$. If the same screen S needs to be displayed to users in role R_2 during activity A_2 , then object S could be assigned two new superior entities: $R_2 \rightarrow S$ and $A_2 \rightarrow S$. However, this produces an unintended side-effect of making screen S visible for users in role R_2 during activity A_1 , because S is now their subordinate, too.

This side effect could be eliminated by cloning S as S' [3] and making clone S' , instead of S , a subordinate of R_2 and A_2 . Cloning, however, is inefficient because it duplicates data and creates referential integrity problems [4] when data in the original or the clone changes.

4 Proposed Solution

Whenever there is a need for an entity to appear in more than one context, we create a new *indirector* entity with a 'cloneof' relationship to the original entity. The indirector gains a) a property containing the identity of its original; b) a flag property for whether it inherits its original's superior relationships; and c) a flag property for whether it inherits its original's subordinate relationships. Any properties set on the indirector would override similar properties of the original. Any properties not set on the indirector would be inherited from the original.

Table 1. Exhaustive enumeration of indirector types. Each configuration describes whether the indirector has (a) the same superiors, (b) the same subordinates and (c) the same properties.

| ## | Configuration | Same superiors | Same subordinates | Same attributes |
|----|-------------------|----------------|-------------------|-----------------|
| 1 | Reflection | Yes | Yes | Yes |
| 2 | Masked Reflection | Yes | Yes | No |
| 3 | Twin | Yes | No | Yes |
| 4 | Masked Twin | Yes | No | No |
| 5 | Partner | No | Yes | Yes |
| 6 | Masked Partner | No | Yes | No |
| 7 | Understudy | No | No | Yes |
| 8 | Masked Understudy | No | No | No |

Table 1 summarizes all possible configurations of shared data indirectors. Configuration 1, named “Reflection,” corresponds to full sharing of relationships and attributes, which would be useful in cases where multiple instances of a subordinate object comprise a superior object. In case 2, “Masked Reflection,” indirectors share relationships, but the attributes of the original object may be localized on the indirector without modifying the values of the original object, which can be useful, for example, for software localization/internationalization. In case 3, “Twin” an indirector shares superiors with its original, but has distinct subordinates, which can be useful in describing a distinct configuration for the same entity, or for creating different subordinate structures in different contexts. Case 4, “Masked Twin,” allows for localization of a Twin indirector. Case 5, “Partner,” defines a distinct manifestation of the same object in multiple contexts with the same subordinate structure in each context. This would be useful, for example, in defining the screen aliases, discussed in the previous section, by making the indirectors subordinate to the distinct superiors and connecting the indirectors to the original object and thereby sharing the original’s subordinates and properties. Case 6 allows localization of a Partner indirector. In Case 7, the indirectors share properties, but have their own distinct superiors and subordinates, which can be useful, for example, in defining the same object in multiple contexts and multiple configurations. Finally, Case 8, “Masked Understudy” allows for the localization of attributes for Understudy Indirectors.

References

- [1] Briggs, R., Kolfshoten, G., de Vreede, G., Albrecht, C., & Lukosch, S. (2010). Facilitator in a Box: Computer Assisted Collaboration Engineering and Process Support Systems for Rapid Development of Collaborative Applications for High-Value Tasks. *Proceedings of HICSS 2010*, pp. 1-10, IEEE Computer Society Press.
- [2] Mametjanov, A., Kjeldgaard, D., Pettepier, T., Albrecht, C., Lukosch, S., & Briggs, R. O. (2011). ARCADE: Action-centered Rapid Collaborative Application Development and Execution. *Proceedings of HICSS 2011*, pp. 1-10, IEEE Computer Society Press.
- [3] Meyer, B. 1988. *Object-oriented software construction*. Vol. 59: Citeseer.
- [4] Markowitz, V.M. 1990. Referential integrity revisited: An object-oriented perspective.

Appendix C

Earlier Annual Progress Reports

Annual Report 2008-2009

To: technicalreports@afosr.af.mil

Dr. David Luginbuhl, david.luginbuhl@afosr.af.mil

Subject: Annual progress Statement to Dr. David Luginbuhl

Contract/Grant Title: BattleSpace ActionCenters

Contract/Grant#: FA9550-08-1-0263

Reporting Period: 15 May 2008 to 14 May 2009

Annual accomplishments:

Intellectual Achievements:

- Derived a 7 layer model of collaboration which was adopted by USSTRATACOM's GISC as the foundation for designing and measuring large-scale multi-agency collaborative intelligence analysis exercises.
- Created a taxonomy of Collaboration Technology used as a foundation for process support systems (PSS) component capabilities.

Technical Achievements:

- Conducted three international requirements workshops for architectural design of Computer Assisted Collaboration Engineering (CACE) and PSS
 - Created a server-side data architecture around a Universal Data Model
 - Created a collaborative messaging architecture.
 - Created a browser-based client architecture for CACE
 - Created conceptual class architecture for ActionCenters
 - Established developer coding standards for CACE/PSS
- Created first draft of Collaboration Engineering Modeling Language (CEML) standard
- Specified data requirements for ActionCenter elements
- Created conceptual UI designs for Agenda Editor, Activity Editor, ActionCenter Builder, and Screen Editor.
- Implemented CACE framework, Project Explorer, Security, Administration, User Management, and Recycle Bin for the CACE tool

Operational Achievements

- Observed warfighters in mission-critical collaborative operations:

- Multi-agency crisis response exercise (Iowa & Nebraska Army & Air National Guard, and 40 civilian law enforcement, government, and NGO organizations)
- Multi-agency intelligence analysis limited objective experiment (USSTRATCOM, NORTHCOM, CENTCOM, CIA, FBI & other civilian and military agencies)

Archival publications (published) during reporting period:

Journal Articles

24. Briggs, R. O., Reinig, B. A., & Vreede, G. J. d. (2008). The Yield Shift Theory of Satisfaction and its application to the IS/IT domain. *Journal of the Association for Information Systems*, 9(5), 267-293. <http://aisel.aisnet.org/jais/vol9/iss5/2>
25. Briggs, R.O. and Murphy, J. (In Press). Discovering and Evaluating Collaboration Engineering Opportunities: An Interview Protocol Based on the Value Frequency Model. *Group Decision and Negotiation*.
26. Deokar, A., Kolfschoten, G.L., Vreede, G.J. de (2008), Prescriptive Workflow Design for Collaboration-intensive Processes using the Collaboration Engineering Approach, *Global Journal of Flexible Systems Management*, 9(4), 13-24.
27. Kolfschoten, G.L. Frantzeskaki, N. de Haan, A. Verbraeck, A. (2008), Collaborative modeling lab to increase learning engagement, *Journal of the Higher Education Academy Engineering Subject Center*, Volume3 issue2, pp.21
28. Kolfschoten, G.L., Vreede, G.J. de (in Press), A Design Approach for Collaboration Processes: A Multi-Method Design Science Study in Collaboration Engineering, *Journal of Management Information Systems*.
29. Kolfschoten, G.L., Vreede, G.J. de, Briggs, R.O., Sol, H.G. (in Press), Collaboration 'Engineerability', *Group Decision & Negotiation*.
30. Niederman, F., Briggs, R. O., Vreede, G. J. d., & Kolfschoten, G. L. (2008). Extending the contextual and organizational elements of adaptive structurization theory in GSS research. *Journal of the Association for Information Systems*, 9(10/11), 633-652.
31. Niederman, F., Briggs, R.O., Vreede, G.J. de, Kolfschoten, G.L. (2008), Purposive Adaptive Structuration: The role of conscious agents in creating and utilizing new structures in collaboration, *Journal of the Association for Information Systems*, 9, 10.
32. Nunamaker, J. F., Jr., Reinig, B. A., & Briggs, R. O. (2009). Principles for Effective Virtual Teamwork. *Communications of the ACM*, 52 (4), Pages 113-117.
33. Reinig, B. A., & Briggs, R. O. (2008). on the relationship between idea-quantity and idea-quality during ideation. *Group Decision and Negotiation*, 17(5), 403-420.
34. Reinig, B., Briggs, R.O., Vreede, G.J. de (2009), A Cross-cultural study of the Relationship between Perceived Changes in Likelihood of Goal Attainment and Satisfaction with Technology Supported Collaboration, *International Journal for e-Collaboration*, 5(2), 61-74
35. Renger, M., Kolfschoten, G.L., Vreede, G.J. de (2008), Challenges in Collaborative Modeling: A Literature Review & Research Agenda, *International Journal of Simulation and Process Modeling*, 4(3/4), 248-263.

36. Vreede, G.J. de, Briggs, R.O., Massey, A. (2009), Collaboration Engineering: Foundations and Opportunities, Editorial, *Journal of the Association of Information Systems*, 10(3), 121-137.

Conference Proceedings

58. Badura, V., Read, A., Briggs, R.O., Vreede, G.J. De (2009), Exploring the Effects of a Convergence Intervention on The Artifacts of An Ideation Activity During Sensemaking, *CRIWG 2009*.
59. Badura, V., Read, A., Briggs, R.O., Vreede, G.J. De. (In Press). Exploring The Effects of a Convergence Intervention on Ideation Artifacts: A Multi-Group Field Study. *Proceedings of AMCIS 2009, The Americas Conference on Information Systems*.
60. Badura, V., Read, A.S., Briggs, R.O., Vreede, G.J. De (2009). Exploring The Effects of a Convergence Intervention on The Artifacts of An Ideation Activity During Sensemaking, In: Edick, N., Vreede, G.J. De (Eds.), *Proceedings of The Advances in Collaboration Science Research*, Third Research Seminar of The Center For Collaboration Science, 27 February 2009, University of Nebraska Read, A.S., Renger, M., Briggs, R.O., And Vreede, G.J. De. (2009). *Fundamental Topics of Organizing: Research Agenda*. Proceedings of The 42ND Hawaii International Conference on System Sciences, 1-10, on Cd.
61. Barjis, J. Kolfschoten, G.L. And Verbraeck, A. (2009) "Collaborative Enterprise Modeling," In Pret, Pp. 50-62
62. Boeijs, R.; Kolfschoten, G.L.; Vries, P. De And Veen, W. (2009) Knowledge Workers And The Realm of Social Tagging, Hawaii International Conference on System Science, Waikoloa, Ieee Computer Society Press.
63. Briggs, R. O., Davis, A. J., & Murphy, J. D. (2008). *An Interview Protocol For Discovering And Assessing Collaboration Engineering Opportunities*. Proceedings of The 41ST Hawaii International Conference on System Sciences, 1-10, on Cd.
64. Briggs, R.O., Murphy, J., Davis, A.J., And Carlisle, T. (2009). *Predicting Change: A Study of The Value Frequency Model For Change of Practice*. Proceedings of The 42ND Hawaii International Conference on System Sciences, 1-10, on Cd.
65. Briggs, R.O., Vreede, G.J. De, Reiter-Palmon, R., Harland, L. (2009). Computer Assisted Collaboration Engineering And Process Support Systems: The Battlespace Actioncenters Project, In: Edick, N., Vreede, G.J. De (Eds.), *Proceedings of The Advances in Collaboration Science Research*, Third Research Seminar of The Center For Collaboration Science, 27 February 2009, University of Nebraska At Omaha, Omaha, Ne.
66. Davis, A., Badura, V., Vreede, G.J. De (2008), Understanding Methodological Differences to Study Convergence in Group Support System Sessions, *CRIWG 2008*, September 14-18, Omaha, Nebraska.

67. Duivenvoorde, G.P.J.; Kolfschoten, G.L.; Briggs, R.O. And Vreede, G.J. De (2009). Towards An Instrument to Measure Successfulness of Collaborative Effort From A Participant Perspective, Hawaii International Conference on System Science, Waikoloa, Ieee
68. Frantzeskaki, N. De Haan, A. Di Ruggero, O. And Kolfschoten, G.L. (2009) "Lessons Learned From a Multi-Modal Conceptual Modeling Course - The "Introduction to Policy Analysis" Course's Experience As a Successful Grassroots Project of The Delft University of Technology," In Inted, Pp. 1-9.
69. Frantzeskaki, N. De Haan, A. Walker W. And Kolfschoten, G.L. (2008), Three Challenges, Four Pitfalls And Five Solutions When Teaching Conceptual Modeling, International Conference of Education, Research And Innovation (Iceri 2008), 17-19 November 2008, Madrid (Spain).
70. Kolfschoten, G. L., & Briggs, R. O. (In Press). *Modifiers: Increasing Richness And Nuance of Design Pattern Languages*. Proceedings of the European Conference on Pattern Languages of Programs, Irsee, Uvk.
71. Kolfschoten, G. L., Duivenvoorde, G., Briggs, R. O., & Vreede, G. J. D. (2009). *Towards An Instrument to Measure Successfulness of Collaborative Effort From a Participant Perspective*. Proceedings of the 42ND Hawaii International Conference on System Sciences, 1-10, on Cd.
72. Kolfschoten, G. L., Grünbacher, P., & Briggs, R. O. (2008). *Modifiers For Quality Assurance in Group Facilitation*. Groupware: Design, Implementation, And Use: 14TH International Workshop, CRIWG 2008. Omaha, Nebraska, September 2008, Proceedings.
73. Kolfschoten, G.L. And Briggs, R.O. (2008) Modifiers: Increasing Richness And Nuance of Design Pattern Languages. Proceedings of the European Conference on Pattern Languages of Programs, Irsee, Uvk.
74. Kolfschoten, G.L., Briggs, R.O., Vreede, G.J. De (2009), A Diagnostic To Identify And Resolve Different Sources of Disagreement in Requirements Engineering, In: Kilgour, M., Wang, Q. (Eds), *Proceedings of GDN 2009: An International Conference on Group Decision And Negotiation*, Toronto, Canada, June 2009, P. 108-116.
75. Kolfschoten, G.L., Duivenvoorde, G., Briggs, R.O., Vreede, G.J. De (2009), Practitioners Vs Facilitators A Comparison of Participant Perceptions on Success, *Proceedings of the 42ND Hawaiian International Conference on System Sciences*, Los Alamitos: Ieee Computer Society Press.
76. Kolfschoten, G.L., Duivenvoorde, G., Briggs, R.O., Vreede, G.J. De (2009), Towards An Instrument to Measure Successfulness of Collaborative Effort From a Participant Perspective, *Proceedings of the 42ND Hawaiian International Conference on System Sciences*, Los Alamitos: Ieee Computer Society Press.
77. Kolfschoten, G.L., Kosterbok, J. Hoekstra, A. (2008). A Transferable Thinklet Based Process Design For Integrity Risk Assessment in Government Organizations, Proceedings of the Group Decision And Negotiation Conference, Coimbra, Inesc Coimbra.
78. Kolfschoten, G.L.; Frantzeskaki, N.; Haan, A. De; Duivenvoorde, G.P.J. And Verbraeck, A. (2009). Collaborative Modeling Lab to Increase Learning Engagement; Comparing Manual Modeling With Interactive Whiteboards, Hawaii International Conference on System Science, Waikoloa, Ieee Computer Society Press.

79. Kolfschoten, G.L.; Grunbacher, P. And Briggs, R.O. (2008). Modifiers For Quality Assurance in Group Facilitation, In: Briggs, R.O., Antunes, P. And Vreede, G.J. (Eds.) *Groupware: Design, Implementation And Use, Proceedings of Criwig, Omaha, Usa, Lncs* Springer-Verlag.
80. Kolfschoten, G.L.; Niederman, F.; Vreede, G.J. De And Briggs, R.O. (2008). Roles in Collaboration Support And the Effect on Sustained Collaboration Support, Hawaii International Conference on System Science, Waikoloa, Ieee Computer Society Press.
81. Mittleman, D. M., Briggs, R. O., Murphy, J. D., & Davis, A. J. (2008). *Towards a Taxonomy of Groupware Technologies*. Groupware: Design, Implementation, And Use: 14TH International Workshop, CRIWG 2008. Omaha, Nebraska, September 2008.
82. Newlon, C.M., Pfaff, M., Patel, H., Vreede, G.J. De, Macdorman, K. (2009), Mega-Collaboration: the Inspiration And Development of An Interface For Large-Scale Disaster Response, *6TH International Conference on Information Systems For Crisis Response And Management (Iscram)*, 10-13 May 2009, Göteborg, Sweden.
83. Read, A., Briggs, R.O., Vreede, G.J. De (2009), Understanding Relationships in Software Requirements, *Proceedings of the Cors-Informs International Meeting*, Toronto, Canada, 14-17 June 2009.
84. Read, A., Nguyen, C., Gallagher, E., Vreede, G.J. De (2009), Generating User Stories in Groups, *Mwais 2009*, Madison, SD, 22-23 May 2009.
85. Read, A.S., Renger, D.R.M., Briggs, R.O., Vreede, G.J. De (2009), Fundamental Topics of Organizing: A Research Agenda, *Proceedings of the 42ND Hawaiian International Conference on System Sciences*, Los Alamitos: IEEE Computer Society Press.
86. Renger, M., Kolfschoten, G.L., Vreede, G.J. De (2008), Challenges With Collaborative Modeling: A Literature Review, In: Jan L.G. Dietz, Antonia Albani, Joseph Barjis, Peter Rittgen (Eds), *Advanced Enterprise Engineering*, Lecture Notes in Business Information Processing, Berlin: Springer-Verlag (*Ais Sigmas Best Paper Award*).
87. Renger, M., Kolfschoten, G.L., Vreede, G.J. De (2008), Patterns in Collaborative Modeling: A Literature Review, In: Costa, J. (Ed.), *Proceedings of Group Decision & Negotiation 2008*, Coimbra, Portugal.
88. Renger, M., Kolfschoten, G.L., Vreede, G.J. De (2008), Using Interactive Whiteboard Technology to Support Collaborative Modeling, *CRIWG 2008*, September 14-18, Omaha, Nebraska.
89. Steinhauser, L., Read, A., Vreede, G.J. De (2008), Studying the Adoption of Collaborative Work Practices Using the Value Frequency Model, In: Germonprez, M., Iversen, J. (Eds), *Proceedings of the Midwest United States Association For Information Systems 3RD Annual Conference*, Eau Claire, Wisconsin, May 2008.
90. Vreede, G.J. De, Briggs, R.O. Reinig, B. (2008), E-Collaboration Satisfaction: Empirical Field Studies of Disconfirmation Theory across Two Countries, *Proceedings of AMCIS-14*, August 14-17, Toronto, Canada.

Book Chapters

1. Briggs, R.O., Antunes, P., Vreede, G.J. De, Read, A.S. (2008), Groupware: Design, Implementation, and Use. *Proceedings of CRIWG 2008*, Berlin: Springer-Verlag.
2. Davis, A., Vreede, G.J. De, Pietron, L. (2009), A Repeatable Collaboration Process For Incident Response Planning, In: Knapp, K.J. (Ed.), *Cyber-Security And Global Information Assurance: Threat Analysis And Response Solutions*, Pp. 250-264.

3. Edick, N., Vreede, G.J. De (Eds.) (2009), *Proceedings of the Advances in Collaboration Science Research*, Third Research Seminar of the Center For Collaboration Science, 27 February 2009, University of Nebraska At Omaha, Omaha, Ne.
4. Kolfschoten, G.L, Briggs, R.O. Vreede, G.J. De (2009), Design Patterns For Facilitation in E-Collaboration, In: Kock, N. (Ed.), *E-Collaboration: Concepts, Methodologies, Tools, And Applications* (3 Volumes), Hershey, Pa: Information Science Reference. *Reprint from the Encyclopedia of E-Collaboration*.
5. Kolfschoten, G.L., Briggs, R.O., Vreede, G.J. De (2009), A Technology For Pattern-Based Process Design And Its Application to Collaboration Engineering, In: Rummler, S., Ng, K.B. (Eds), *Collaborative Technologies And Applications For Interactive Information Design: Emerging Trends in User Experiences*, Hershey, Pa: Igi Global.
6. Tarmizi, H., Vreede, G.J. De (In Press), Patterns of Facilitation in Online Communities of Practice, Yoong, P. (Ed.), *Leadership in the Digital Enterprise: Strategies for Planning and Training*.
7. Tarmizi, H., Vreede, G.J. De, Zigurs, I. (2009), Supporting Facilitators in Communities of Practice via Design And Technology, In: Kock, N. (Ed.), *E-Collaboration: Concepts, Methodologies, Tools, And Applications* (3 Volumes), Hershey, Pa: Information Science Reference. *Reprint From the International Journal on E-Collaboration*.

Conference Abstracts

3. Read, A., Briggs, R.O., Vreede, G.J. De (2009), Understanding Relationships in Software Requirements, In: Kilgour, M., Wang, Q. (Eds), *Proceedings of GDN 2009: An International Conference on Group Decision And Negotiation*, Toronto, Canada, 14-17 June 2009, P. 150.
4. Vreede, G.J. De (2009), Collaboration Engineering: Technical And Methodological Advances, In: Kilgour, M., Wang, Q. (Eds), *Proceedings of GDN 2009: An International Conference on Group Decision And Negotiation*, Toronto, Canada, 14-17 June 2009, P. 178.

Electronic copies of these publications are available upon request.

Changes in research objectives, if any: None

Change in AFOSR program manager, if any: None

Extensions granted or milestones slipped, if any: None

Include any new discoveries, inventions, or patent disclosures during this reporting period (if none, report none): None

Annual Report 2009-2010

To: technicalreports@afosr.af.mil

Dr. David Luginbuhl, david.luginbuhl@afosr.af.mil

Subject: Annual progress Statement to Dr. David Luginbuhl

Contract/Grant Title: BattleSpace ActionCenters

Contract/Grant#: FA9550-08-1-0263

Reporting Period: 15 May 2009 to 14 May 2010

Annual accomplishments:

Intellectual Achievements:

- Derived the inductive and deductive logical foundations for the Seven Layer Model of Collaboration.
- Developed conceptual foundations for the Universal Data Model

Technical Achievements:

- Implemented three technical innovations that should reduce development cycles for collaboration software:
 - Universal Data Model (UDM). A server that accepts any data in any set of relationships in real time without having to revise server-side metadata.
 - Dynamic Contribution Channels (DCC). Clients receive metadata at run time, and instruct the server what events to publish.
 - Collaboration Support API (CSAPI). Packages difficult-to-build aspects of collaboration technology in a new class of middleware.
- Produced the first fully functional ActionCenter prototype for a military Course of Action Development process using the UDM, DCC, and CSAPI capabilities in order to exercise the back-end capabilities and to test UI concepts for ActionCenters.
- Implemented a Computer Assisted Collaboration Engineering (CACE) rapid development environment with an open, extensible architecture that accepts plug-in collaborative design and configuration editors, and plug-in collaborative components.
- Implemented the following editors and components and plugged them into the CACE framework:
 - Project Explorer
 - ActionCenter Builder
 - Element Editor
 - Palette Explorer
 - Roster Component
 - Navigation Component
- Produced the first simple prototype ActionCenter using the CACE capability.

Archival publications (published) during reporting period:

Journal Articles:

BADURA, V., READ, A., BRIGGS, R.O., VREEDE, G.J. DE (IN PRESS), Coding for Unique Ideas and Ambiguity: The effects of Convergence Intervention on the Artifact of an Ideation Activity, *International Journal of Social and Organizational Dynamics in IT*.

KOLFSCHOTEN, G.L., LUKOSCH, S., VERBRAECK, A., VALENTIN, E., VREEDE, G.J. DE (IN PRESS), Cognitive learning efficiency through the use of design patterns in teaching, *Computers in Education*.

KOLFSCHOTEN, G.L., SECK, M., VREEDE, G.J. DE (2010), How Interactive Whiteboards can be used to Support Collaborative Modeling, *Journal of Universal Computing Science*, 15(16), 3126-3138.

KOLFSCHOTEN, G.L., VREEDE, G.J. DE, PIETRON, L.R. (IN PRESS), A training approach for the transition of repeatable collaboration processes to practitioners, *Group Decision & Negotiation*.

NABUKENYA, J., BOMMEL, P. VAN, PROPER, H.A, VREEDE, G.J., DE (IN PRESS), An Evaluation Instrument for Collaborative Processes: Application to Organizational Policy Making, *Group Decision and Negotiation*.

VREEDE, G.J. DE, BRIGGS, R.O., REITER-PALMON, R. (IN PRESS), Exploring Asynchronous Brainstorming in Large Groups: A Field Comparison of Serial and Parallel Subgroups, *Human Factors: The Journal of Human Factors and Ergonomics Society*.

Conference Proceedings:

ALJAFARI, R., VREEDE, G.J. DE (2010), A Review of Anonymity in Collaborative Settings, *Proceedings of Group Decision & Negotiation 2010*, Delft, the Netherlands, June 2010.

BADURA, V., READ, A., BRIGGS, R.O., VREEDE, G.J. DE (2010), Coding for Unique Ideas and Ambiguity: The effects of Convergence Intervention on the Artifact of an Ideation Activity, *HICSS 2010*.

BRIGGS, R.O., KOLFSCHOTEN, G.L., VREEDE, G.J. DE, ALBRECHT, C., LUKOSCH, S. (2010), Facilitator in a Box: Computer Assisted Collaboration Engineering and Process Support Systems for Rapid Development of Collaborative Applications for High-Value Tasks, *HICSS 2010*.

BRIGGS, R.O., KOLFSCHOTEN, G.L., VREEDE, G.J. DE, DEAN, D.L., LUKOSCH, S. (2009), A Seven Layer Model of Collaboration: Good Technology is Not Enough, *30th International Conference on Information Systems*, Phoenix, December 2009.

BRIGGS, R.O., VREEDE, G.J. DE, REITER-PALMON, R., HARLAND, L. (2009), Computer Assisted Collaboration Engineering And Process Support Systems: The Battlespace Actioncenters Project, in: Edick, N., Vreede, G.J. de (eds.), *Proceedings of the Advances in Collaboration Science Research*, Third Research Seminar of the Center for Collaboration Science, 27 February 2009, University of Nebraska at Omaha, Omaha, NE.

- DUIVENVOORDE, G.P.J., LUKOSCH, S.G., VREEDE, G.J. DE, VERBRAECK, A., OVERBEEK, S.J. (2010), Supporting convergence in groups: design and evaluation of idea similarity detection and a pre-selection method, *Proceedings of Group Decision & Negotiation 2010*, Delft, the Netherlands, June 2010.
- NGUYEN, C., GALLAGHER, E., READ, A., VREEDE, G.J. DE (2009), Generating User Stories in Groups, *CRIWG 2009*.
- BRIGGS, R.O., KOLFSCHOTEN, G.L., VREEDE, G.J. DE, ALBRECHT, C.C., LUKOSCH, S.G., & DEAN, D.L. (2009) A Seven-Layer Model of Collaboration: Separation of Concerns for Designers of Collaboration Systems. *Proceedings of the International Conference on Information Systems*. AIS Press, Pages 1-14 (On CD).
- BADURA, V., READ, A., BRIGGS, R.O., & VREEDE, G.J. DE. (2009). Exploring the Effects of a Convergence Intervention on Ideation Artifacts: A Multi-Group Field Study. *Proceedings of AMCIS 2009, The Americas Conference on Information Systems*, 1-9.
- KOLFSCHOTEN, G.L. BRIGGS, R.O., & VREEDE, G.J. DE (2009). A Diagnostic to Identify and Resolve Different Sources of Disagreement in Collaborative Requirements Engineering. *Proceedings of the International Conference on Group Decision and Negotiation*, Toronto, 100-108.
- READ, A., BRIGGS, R.O., & VREEDE, G.J. DE. (2009). Understanding Relationships in Software Requirements, *Proceedings of the CORS-INFORMS International Meeting*, Toronto, Canada, June, 14-17.

Book (Chapters):

- KOLFSCHOTEN, G.L., LOWRY, P.B., DEAN, D.L., VREEDE, G.J. DE, BRIGGS, R.O., Patterns in Collaboration, Nunamaker, J.F. Jr., Romano, N.C. Jr., Briggs, R.O. (eds), *AMIS Volume on Collaboration Science*.
- KOLFSCHOTEN, G.L., VREEDE, G.J. DE, BRIGGS, R.O. (IN PRESS), Collaboration Engineering. In Kilgour, D. M. & Eden, C. (Eds.). *Handbook of Group Decision and Negotiation*. Dordrecht: Springer.
- MARSHALL, G., & VREEDE, G. J. DE (EDS.). (2010). *Proceedings of the Advances in Collaboration Science Research*. Fourth Annual Research Seminar of the Center for Collaboration Science. Omaha: University of Nebraska at Omaha.
- KOLFSCHOTEN, G.L., BRIGGS, R.O., & VREEDE, G.J. DE (2009). A technology for pattern-based design and its application to collaboration engineering. In Rummler, Scott and Ng, K.B. (eds.), *Collaborative Technologies and Applications for Interactive Information Design: Emerging Trends in User Experiences*. Hershey, PA: IGI Global, Information Science Reference, 1-18.
- KOLFSCHOTEN, G.L. BRIGGS, R.O. & VREEDE, G.J. DE (2009). Design patterns for facilitation in e-collaboration, in N. Kock (Ed.), *E-Collaboration: Concepts, Methodologies, Tools, and Applications*. New Jersey: IGI Global Information Science Reference.

Conference Abstracts:

None

Electronic copies of these publications are available upon request.

Changes in research objectives, if any: None

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Include any new discoveries, inventions, or patent disclosures during this reporting period (if none, report none): None